



G E N E R A L M O T O R S C O M P A N Y

# *Evolution of sustainable propulsion technologies*

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Government Relations Manager



# Items List

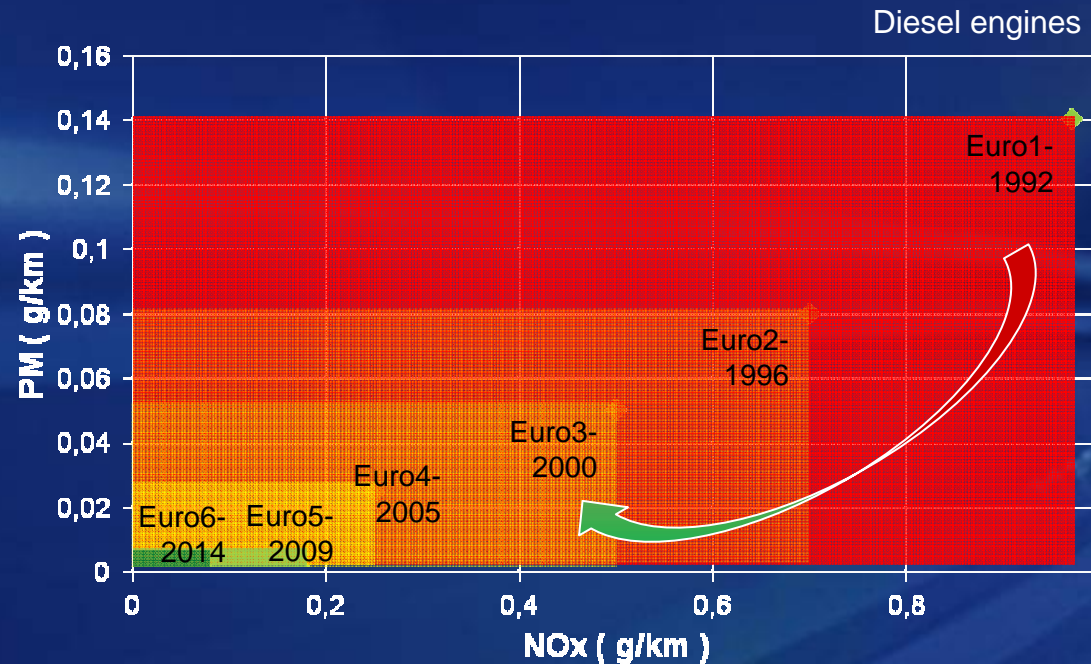


- ✓ Propulsion Technologies evolution
- ✓ ICE Optimization
- ✓ Hybrid vehicles
- ✓ Electric vehicles





# 22 years to go from Euro1 to Euro6



Huge reduction in emissions leading to development and applications of new technologies to diesel engines (after treatment, common rail, engine management system, turbo-charging)



# *Sustainable Mobility Dilemma*



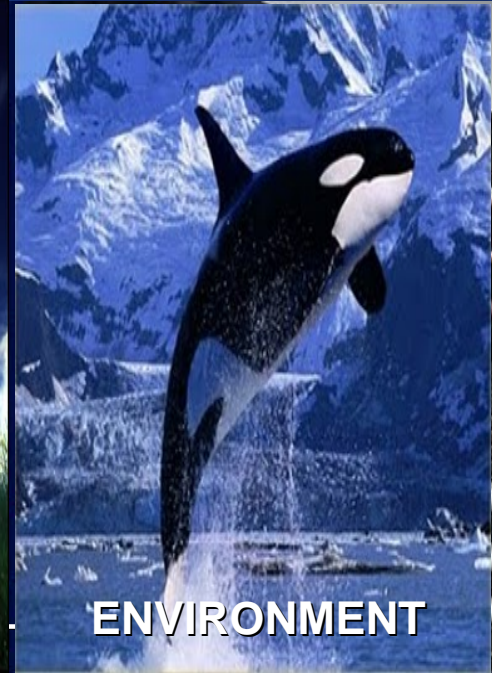
ENERGY SOURCES



WATER



AIR



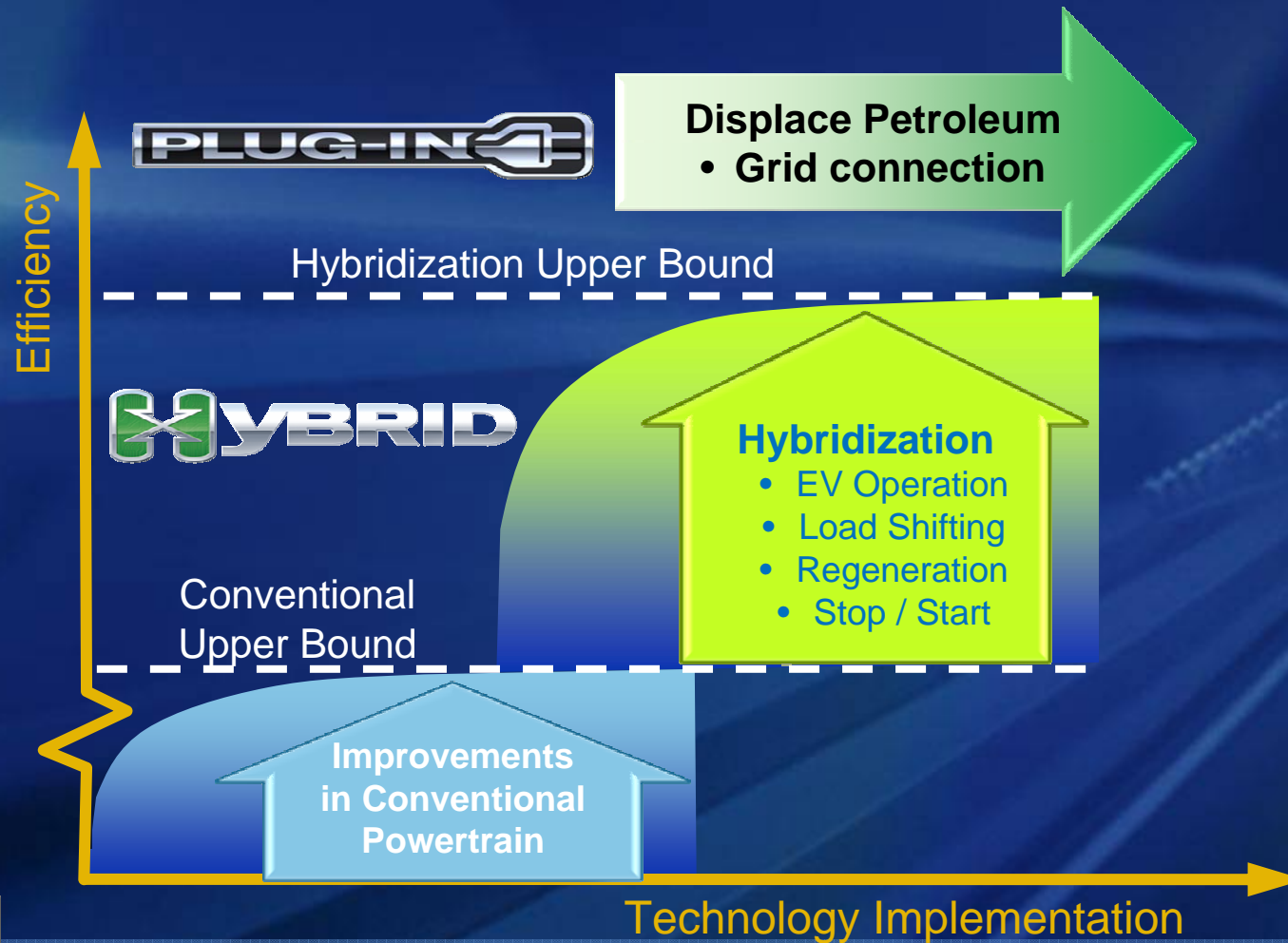
ENVIRONMENT

To satisfy the mobility needs of our  
Present generation  
Preserving the resources to satisfy  
the needs of future generations





# *Electrification: enabler of further steps in efficiency improvement*



# Gasoline engines - Current state of the Art

Spark Ignition  
Direct Injection



Cam Phasing, Variable Valve  
Lift, Active Fuel Management



Downsized SIDI  
Turbo Boosting



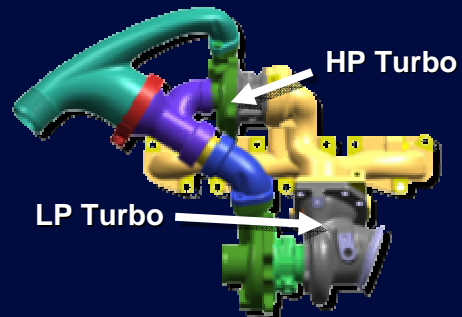
Advanced Combustion



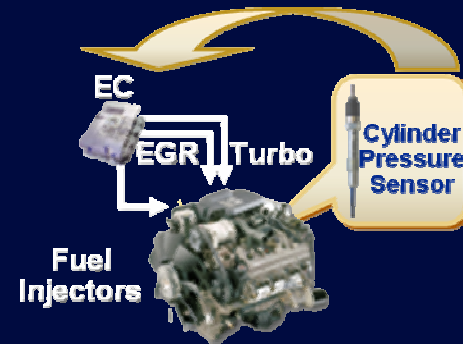


# Diesel engines – Current State of the Art

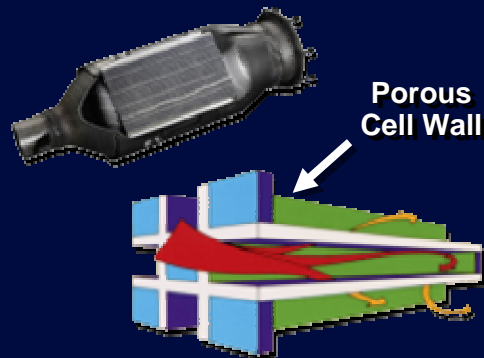
### Advanced Boosting with Small Displacement



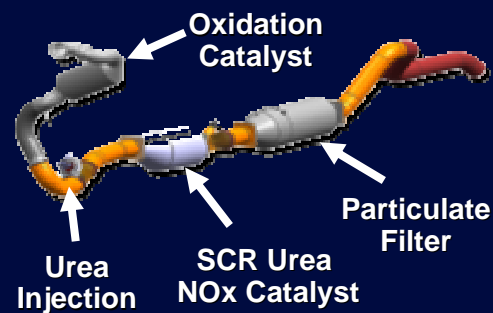
### Cylinder Pressure Sensing



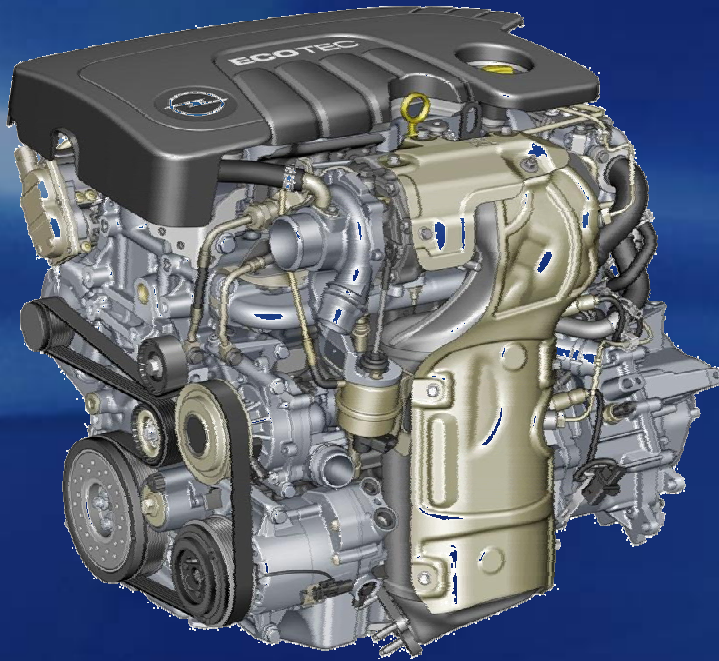
### Diesel Particulate Filter



### NO<sub>x</sub> Aftertreatment



# ***New 1.6-liter diesel engine powered by GM***



***New family of state-of-the-art, four-cylinder, 1.6-liter diesel engines***

***Class-leading refinement, high power/torque density***

***Fuel consumption reduced by up to 10 percent***

***Compliant with future Euro 6 emissions requirements***





# System Optimization in the Vehicle



- These downsized, powerful powertrains can still achieve their full potential, if combined with technology improvement

**Powertrain solutions only achieve their full potential, if combined with vehicle level optimizations such as mass reductions & aerodynamic improvements**



**Maintained Performance**



# ***DOWNSIZED TURBO GASOLINE ENGINE***

## **Chevrolet Cruze Eco**

**1.4L Turbo Ecotec**

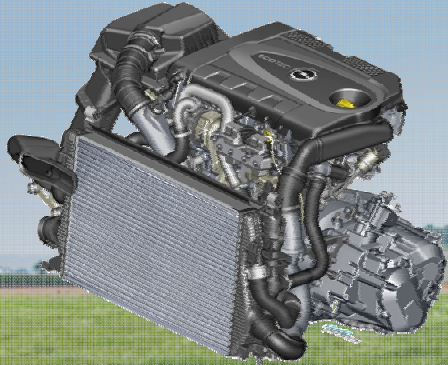
**42 MPG Highway**



42mpg = 17.9 km/l



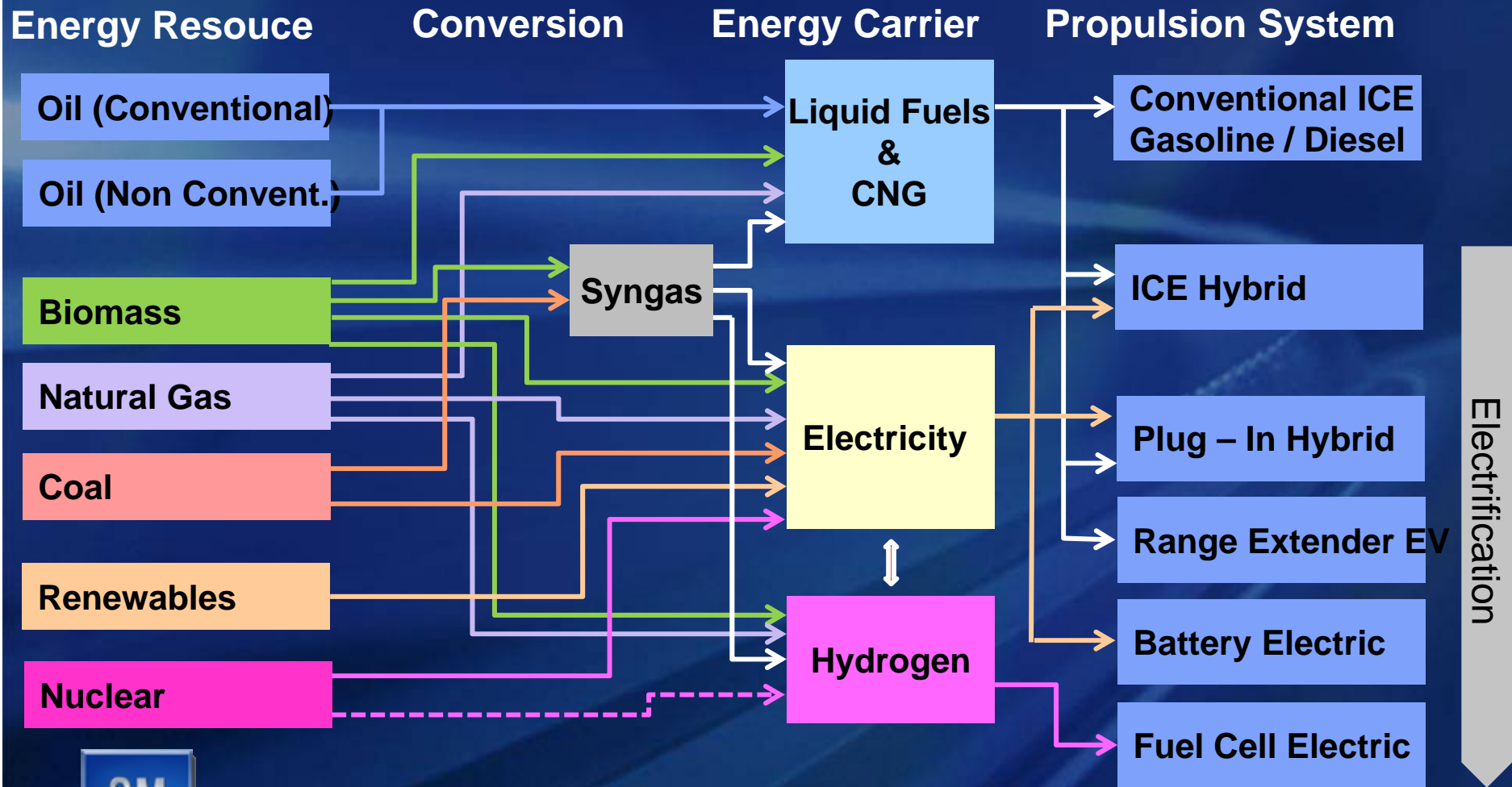
# ***ECOFLEX TURBO DIESEL ENGINE***



**Opel Astra EcoFlex**  
**1.7L CDTI**  
**99g/km CO2**





















# Energy sources, paths, on-vehicle storage and vehicle propulsion systems





# Alternative Fuels

	Source	€/lt Influenced by tx	Emissions (PM/Nox)	CO2	N. fuel pumps (Italy)	Limitations
<b>Gasoline</b>	Refinery	<b>1,81€</b> 41% - indust price 59% - Taxes			<b>22,900</b>	
<b>Diesel</b>	Refinery	<b>1,71€</b> 47% - Indust price 53% - Taxes			<b>22,900</b>	
<b>CNG</b>	Natural Gas (Metano)	<b>0,99€</b> 80% - Indust. Price 20% - Taxes - TBC			<b>790</b>	
<b>LPG</b>	Refinery (GPL)	<b>0,87€</b> 80% - Indust. Price 20% - Taxes - TBC			<b>2,970</b>	
<b>Ethanol (E85)</b>	Canna da zucchero ...	<b>NN</b>			<b>&lt;10</b>	
<b>Biodiesel</b>	Olio estratto da semi di girasole, soia, colza	<b>NN</b>				



# Alternative Fuels

## Opel Astra Sports Tourer 140 Hp/130 Hp Ds

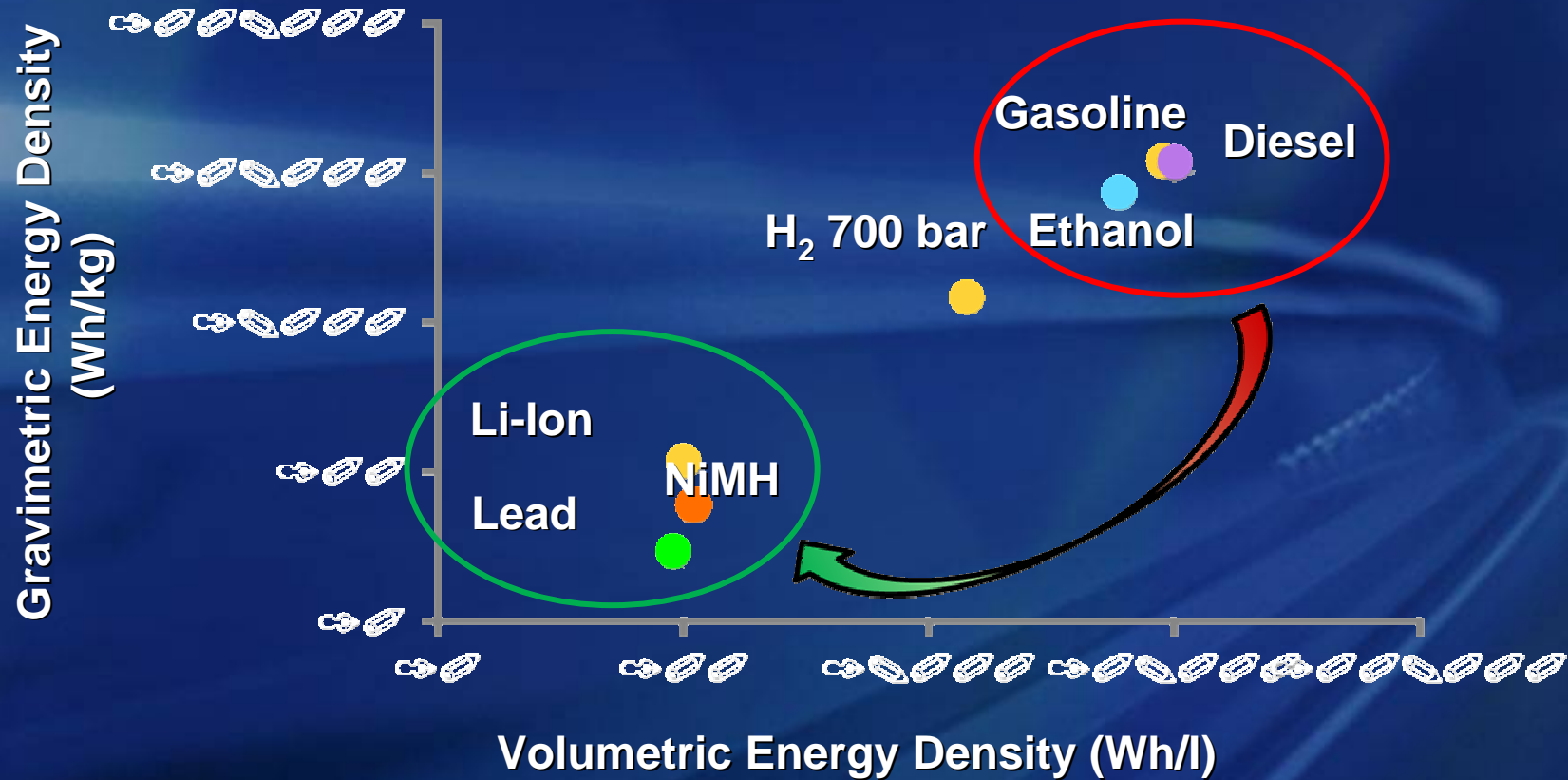
<i>Diesel</i>	4,5	Lt/100 km	1,71	€/lt	3,8	€/50 km	Reference 43% -8%
<i>Gasoline</i>	6,1	Lt/100 km	1,81	€/lt	5,5	€/50 km	
<i>LPG</i>	8,1	Lt/100 km	0,87	€/lt	3,5	€/50 km	
<i>Ampera</i>					1	€/50 km	





# Energy Density in Carriers

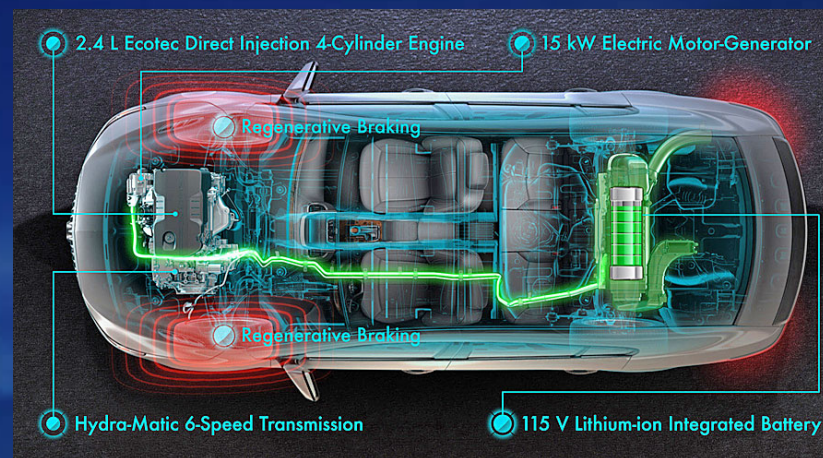
## Gasoline & Diesel vs batteries



# e-Assist Technology



Buick's e-Assist Technology



Mild Hybrid architecture based on:

- State-of-the-art lithium-ion battery
- High power Motor Generator Unit (BAS)
- Real time energy optimizer ECU

Features:

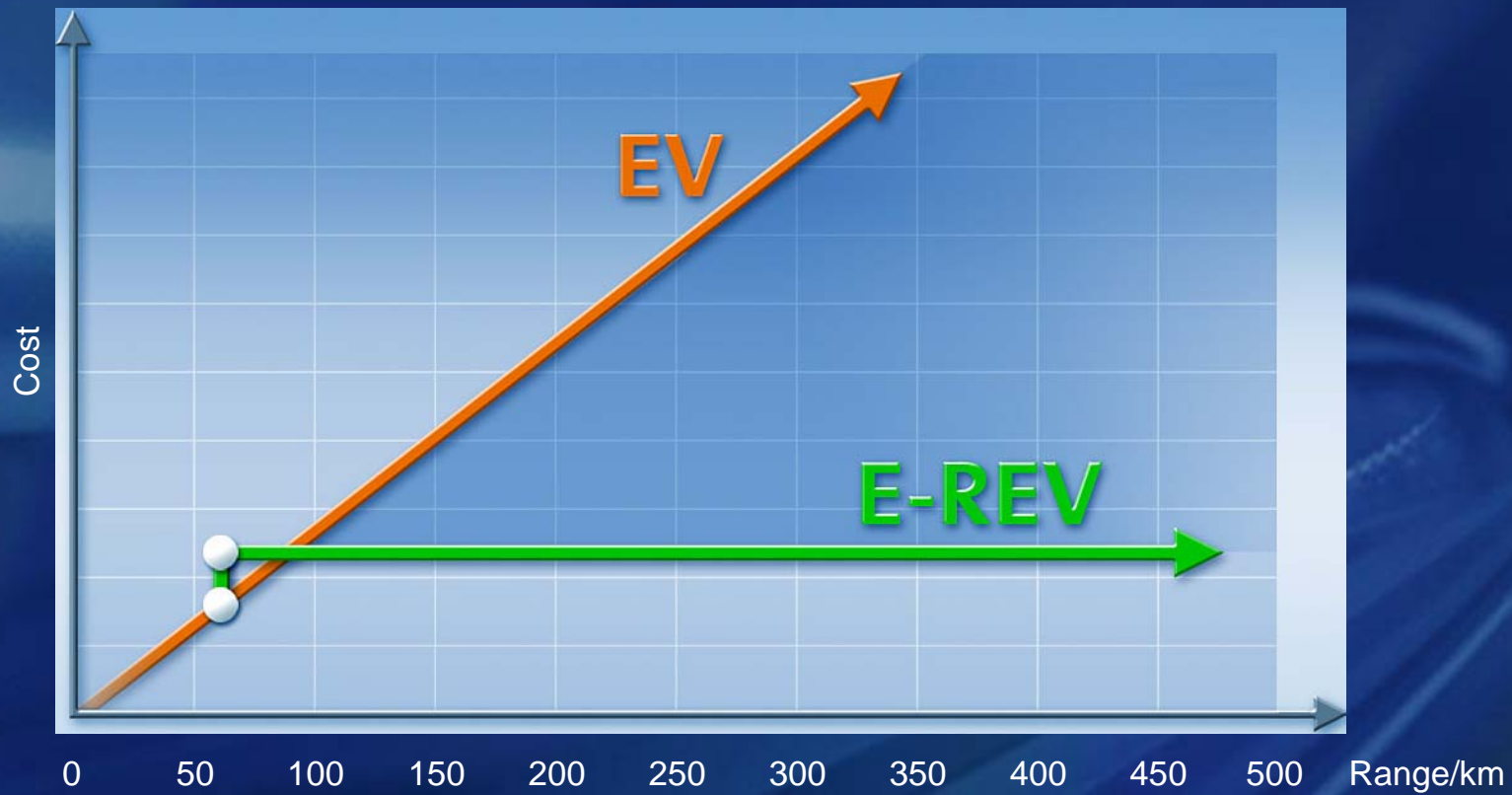
- Enhanced Start & Stop
- Regenerative coasting/braking
- Torque/power electrical assist
- Electric launch



Power Flow Display

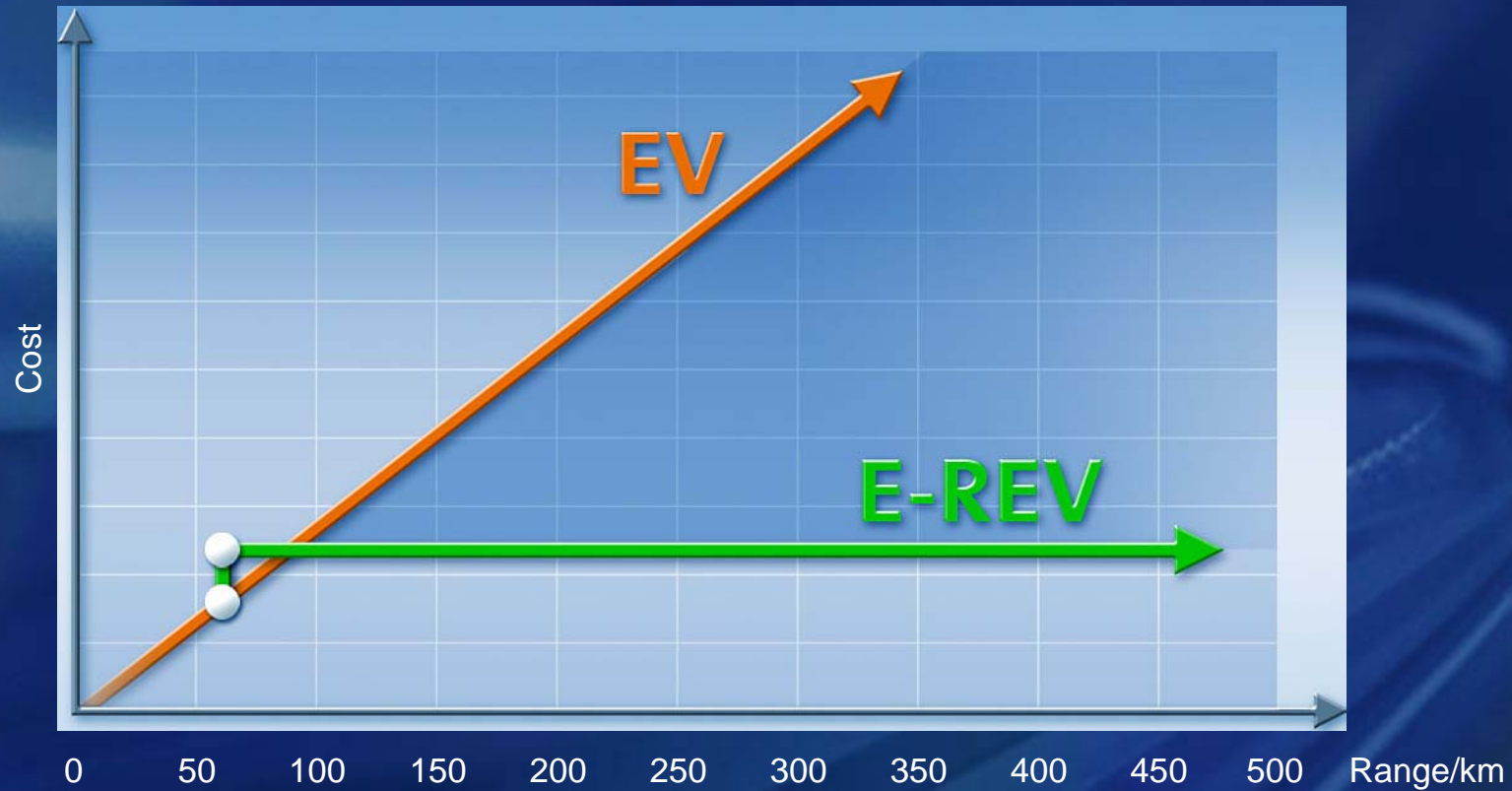


# Range and Cost





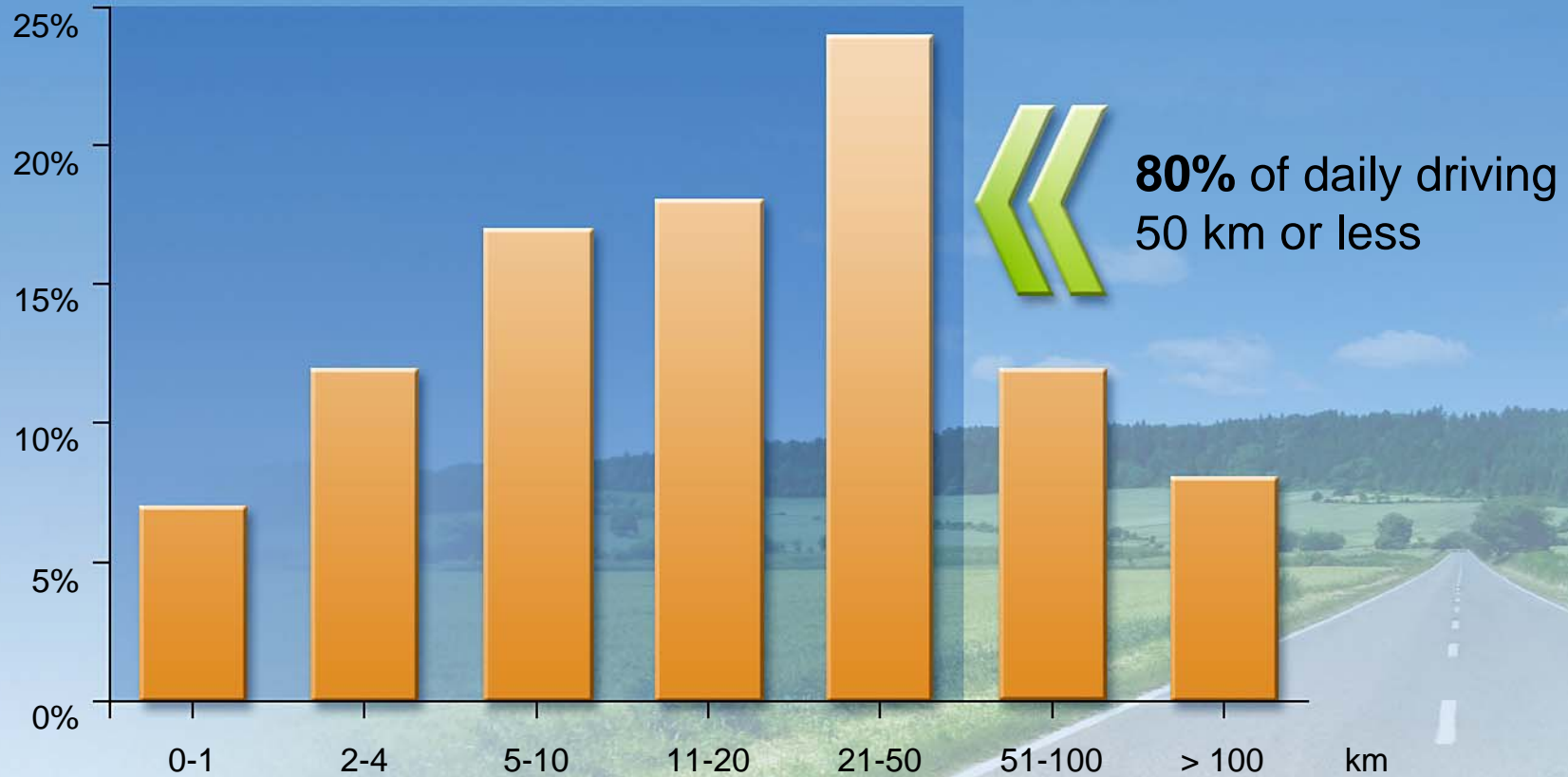
# Range and Recharging Time



→ The same is valid for mass and volume



# Typical Daily Mileage



Source: Mobilität in Deutschland, 2002



# *Opel Ampera* *A Fully Capable Electric Vehicle*



**40–80 km**

Battery-electric driving



**Full usability:**

Performance and refueling  
like conventional vehicles



GM APCE





# Reliability in Daily Use



# *Opel Ampera*

## *A Fully Capable Electric Vehicle*

- Battery not greater than necessary → 4-seater + trunk → primary vehicle
- Opel as first German manufacturer of volume production electric vehicle
- Start of sales: End of 2011





# Chevrolet Spark EV

- This electric mini car utilizes some of the same cutting-edge electric power technology proven in the Chevrolet Volt.
- Motor that delivers 130Hp and 542Nm for instant acceleration, 20kWh Li-Ion battery
- Battery is backed by an 8-year/100,000-mile limited warranty
- It will be sold in USA, initially



80% re-charge in 20min with dedicated SAE Combo DC Fast Charge

Full re-charge in 7 hours with AC 240V station



# *The Challenge of a New Technology*



1983: Martin Cooper introduce  
first Motorola Mobile  
Dynatac 8000 «The Brick»

**4000US\$ - 1000 g**

**«A portable Desk Phone»**



2010: Steve Jobs  
introduces

New Generation iPhone 4  
**300US\$ - 135 g**

**«A Smart Netbook  
integrated in a Mobile  
Case»**

# *It is also the Challenge of Infrastructure*

